# ANCHOR BOLTS CONNECTING STEEL TO CONCRETE

# IR 22-2

Reference: 2001 Title 24, California Building Code, Sections 1923A, 2205A.11 and 2205A.12
2007 Title 24, California Building Code, Section 2204A.2.2 and AISC 360, Section J9
Title 8, Industrial Relations, Sections 1710 (f) (1) (A) and 1710 (b)

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**Purpose:** This Interpretation of Regulations (IR) is applicable to cast-in-place anchor bolts used to fasten structural steel to concrete. The purpose of this IR is to clarify the dimensional requirements, and the acceptability of both full diameter body and reduced body diameter style bolts. This IR is **not** applicable to anchor bolts used to attach wood elements to concrete or to masonry (refer to IR 23-5), bolts used for steel to steel connections, or post-installed bolts (refer to IR 19-1).

**1. DESIGN REQUIREMENTS:** Cut-thread or rolled-thread bolts of **full diameter body style** shall meet the requirements of American Society of Mechanical Engineers (ASME) standard ASME B18.2.1 or ASME B18.2.6 (Section 3 below). Full body style bolts may be designed per Sections 1.1 or 1.2 below.

Rolled-thread bolts of **reduced diameter body style** shall meet the requirements of ASME B18.2.1 (Section 4 below). Reduced body style bolts shall be designed per Section 1.1 below.

**1.1** The construction documents shall indicate that the anchor bolts must meet the requirements of ASTM F-1554. The anchor bolts shall be designed in accordance with ACI 318, Appendix D.

**1.2** When the anchor bolts are designed in accordance with 2001 CBC, Section 1923A.1 (Section 1911A.2 in the 2007 CBC), the body or shank diameters (from Table 3-1 below) shall be specified on the construction documents and utilized for the design. The body or shank diameters herein specified shall supersede ASTM F-1554.

In addition, the minimum number of anchor bolts required for a column base plate is four (4), per Title 8, Industrial Relations, Section 1710 (f) (1) (A). Steel posts weighing 300 lbs. or less, as defined by Title 8, Section 1710 (b), are not subject to this requirement.

Base plate holes for anchor bolts may be oversized per 2001 CBC Section 2205A.11 (for projects submitted under the 2007 CBC, refer to AISC 360, Section J9 and *AISC Manual of Steel Construction*, Table 14-2).

**2. BACKGROUND:** Dimensional requirements for bolts are given in ASME B18.2.1, "Square and Hex Bolts and Screws," and ASME B18.2.6, "Fasteners for Use in Structural Applications." Bolt threads are formed either by cutting or rolling. Dimensional requirements for threads are given in ASME B1.1, "Unified Inch Screw Thread (UN and UNR Thread Form)," and ASME B1.3M, "Screw Thread Gaging Systems for Dimensional Acceptability – Inch and Metric."

Anchor bolts are manufactured from bolt blanks, which is a headed smooth rod or bar intended for subsequent threading. Blanks come in full body diameter and reduced body diameter styles.

**2.1 Cut-Thread Bolts.** The original blank is full diameter body style, and equal to the major thread (outside) diameter. Threads are formed by cutting and removing metal from the blank.

**2.2 Full Diameter Body Style Rolled-Thread Bolts.** The original blank is full diameter body style, and the threaded length portion is reduced to the thread pitch diameter during extrusion. Threads are formed by rotating dies that displace the metal.

**2.3 Reduced Diameter Body Style Rolled-Thread Bolts.** Similar to full diameter body style rolled-thread bolts, except the blank diameter is reduced for the entire bolt length.

**2.4** Commercially, the terms "cut-thread" and "rolled-thread" may not indicate the method of forming threads. The term "cut-thread bolt" may refer to either a cut-thread bolt or a full diameter body style rolled-thread bolt. The term "rolled-thread bolt" may refer to a reduced diameter body style rolled-thread bolt.

**3. FULL DIAMETER BODY STYLE BOLTS:** Dimensional requirements for cut-thread or rolled-thread bolts with full diameter body style are given in Table 3-1.

**Table 3-1 Diameters of Full Diameter Body Style Bolts** [1, 2]

| Nominal Size (inches) | | Body or Shank Diameter (inches) [3] | |
|---|---|---|---|
| | | **Max.** | **Min.** |
| 1/2 | 0.5000 | 0.515 | 0.482 |
| 5/8 | 0.6250 | 0.642 | 0.605 |
| 3/4 | 0.7500 | 0.768 | 0.729 |
| 7/8 | 0.8750 | 0.895 | 0.852 |
| 1 | 1.0000 | 1.022 | 0.976 |
| 1-1/4 | 1.2500 | 1.277 | 1.223 |
| 1-1/2 | 1.5000 | 1.531 | 1.470 |
| 1-3/4 | 1.7500 | 1.785 | 1.716 |
| 2 | 2.0000 | 2.039 | 1.964 |

Notes:
1) Adopted from ASME B18.2.1 and ASME B18.2.6.
2) For bolt diameters not indicated, refer to ASME B18.2.1 and B18.2.6.
3) The body or shank of a bolt is the smooth portion between the head and the threads.

**4. REDUCED DIAMETER BODY STYLE BOLTS:** Dimensional requirements for rolled-thread bolts with reduced diameter body style are given in Table 4-1.

**Table 4-1 Diameters of Reduced Diameter Body Style Bolts** [1, 2]

| Nominal Size (inches) | | Threads per Inch (TPI) [4] | Body or Shank [3] Diameter (inches) | |
|---|---|---|---|---|
| | | | **Max.** | **Min.** |
| 1/2 | 0.5000 | 13 | 0.482 | 0.444 |
| 5/8 | 0.6250 | 11 | 0.605 | 0.559 |
| 3/4 | 0.7500 | 10 | 0.729 | 0.677 |
| 7/8 | 0.8750 | 9 | 0.852 | 0.795 |
| 1 | 1.0000 | 8 | 0.976 | 0.910 |
| 1-1/4 | 1.2500 | 7 | 1.223 | 1.148 |
| 1-1/2 | 1.5000 | 6 | 1.470 | 1.381 |
| 1-3/4 | 1.7500 | 5 | 1.716 | 1.608 |
| 2 | 2.0000 | 4-1/2 | 1.964 | 1.843 |

Notes:
1) Body diameters are based on ASME B18.2.1, Table 2, Notes 7 & 13, and ASTM B1.1, UNRC or 8 UNR series, Class 2A threads.
2) For bolt diameters not indicated, refer to ASME B18.2.1, B18.2.6 and ASTM B1.1.
3) The body or shank of a bolt is the smooth portion between the head and the threads.
4) TPI means threads per inch (ASTM B1.1, UNRC or 8 UNR series, Class 2A threads).